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THE

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OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.

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ERRATA

Page 97 penultimate line. For "high temperature of this dhool" read "high temperature on this dhool".

For "thin" and "thinner" read "light" and "lighter" throughout the article "Fermentation in Relation to Heat developed in Rolling".

NOTICE

In view of the unavoidable delay in the publication of the present issue of the *Tea Quarterly*, which has been largely caused by the recent electric power cuts in Colombo, there is now no possibility of publishing the March, 1956, issue on its due date. This issue will accordingly be combined with the June, 1956, issue and published as a double number. EDITOR.

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THE TEA QUARTERLY

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THE SCARLET MITES OF THE GENUS *BREVIPALPUS* AS PESTS OF TEA IN CEYLON

B. A. Baptist & D. J. W. Ranaweera

All mites belong to the group *Arachnoidea*, which comprises spider-like animals with piercing and sucking mouth parts, which, when full grown possess 4 pairs of legs instead of the 3 pairs of true insects. Mites belonging to the genus *Brevipalpus* have been popularly known as scarlet or orange mites on account of their distinctive, reddish colour. They are all plant-feeding species of minute size and flat, oval form. Several species of these mites have been recorded as causing serious injury to the host plants which they attack and amongst the most serious is the damage caused to tea.

The genus *Brevipalpus* is described by Baker (1945), who recognised its validity as a distinct genus and separated it from *Tenuipalpus* with which it had been held synonymous. He (Baker, 1949) also described the entire range of about 47 species of this genus.

Three species have been collected from tea in Ceylon, the most common being *Brevipalpus australis* Tucker, previously known as *Tenuipalpus obovatus* Donn. This species is also found on tea in India (Andrews and Tunstall, 1945), Malaya (Corbett, 1932) and Java (Dammerman, 1929). In Java it is considered to be the most serious of the mite pests on tea. The other species which have been found on tea in Ceylon are *B. phoenicis* Geijskes, and *B. inornatus* Banks (Loos, 1954). *B. phoenicis* has also been found breeding on *Grevillea robusta* and *Albizzia moluccana* (Loos, 1954) and occasionally in negligible numbers on other shade trees such as *Gliricidia*, dadap and *Acacia*. Scarlet mites are also known to occur on other trees and miscellaneous plants in Ceylon (Light, 1926) but their specific identity has not been recorded.

As a pest of tea in Ceylon, the scarlet mite was first recorded by Green in 1890, at which time it was not considered to be an important pest. Later he (Green, 1900) records it again, but this time as causing serious damage to tea plants, and states that in some instances bushes had been actually killed. Later, in 1914, Rutherford mentions it as a serious pest, recording outbreaks in the Matale, Badulla and Passara districts. Subsequent to this it appears to have receded very much into the background as a pest, though King (1936) reports it as causing a certain amount of defoliation. Last year, however, it was noticed again in serious proportions in the Maskeliya, Dickoya and Dimbula districts (Loos, 1954) and these outbreaks, which have largely persisted since, have also included attacks on shade trees such as *Grevillea* and *Albizzia* as well. Previously the only record of serious attack on shade trees was in 1944 by Gadd, when it was observed to be causing serious damage to *Albizzia* in the Hatton district.

Description and Bionomics.—External Structure.—The *Brevipalpus* mites are all very minute in size, being only about .3 mm long and have flat egg-shaped bodies (Fig. 1). They are also characterised by having needle-like mouth parts (ch), 2 pairs of lateral, lens-like eyes (ey), a distinct dorsal suture (ds) dividing the body into 2 parts, an anterior part called the propodosoma (pr), carrying the mouth parts and the first two pairs of legs (l_1, l_2), and a posterior part or hysterosoma (hy) carrying the remaining two pairs of legs (l_3 l_4). They have also a reticulate skin pattern

and wrinkled legs with a pair of claws, pulvillus and tenent hairs. The palp (pp) on either side of the mouth parts is 4-segmented, in which the large 2nd segment bears a single seta, the 3rd a pair of setae and the minute fourth segment 3 setae.

Of the 3 common species met with in Ceylon *B. australis* is further distinguished by having the tarsi or terminal segments of the 2nd pair of legs provided with 2 characteristic, rod-like, sensory setae (Fig. 2 rs), the dorsal aspect of the body provided with 7 pairs of marginal hysterosomal setae (Fig. 1 hs 1-7) and the reticulate skin pattern (Fig. 1 rp) covering the entire dorsal aspect of the propodosoma. *B. phoenicis* is distinguished by having the tarsus of the 2nd pair of legs provided with 1 terminal rod-like seta, the hysterosoma with 6 pairs of marginal setae and the reticulations not meeting dorso-medianly on the propodosoma. Finally, the reticulate pattern on the venter of the hysterosoma does not extend to the posterior ventral hysterosomal setae. A third species *B. inornatus* Banks, is identical to *B. phoenicis* except in the last feature mentioned, in which it has the reticulate pattern on the ventral aspect of the hysterosoma extending anterior to the posterior ventral hysterosomal setae, a pair of well-developed setae situated about the middle of the ventral aspect of the hysterosoma between the bases of the 4th pair of legs. In size they are all very much the same, measuring approximately .28 mm in length including rostrum and .15 mm in width.

Life cycle.—This has been worked out primarily with *B. australis* on tea, but observations on *B. phoenicis* on tea indicate no important differences. Observations were carried out at St. Coombs, Talawakelle, which had average temperatures of approximately 74°F (day maximum) and 64°F (night minimum) during the period of observation. Males are rare and copulation has not been observed. Females, whether fertilised or not, are capable of laying fertile eggs and commence egg-laying within 3-4 days of reaching the adult stage. Eggs are laid at the rate of about 1 a day over an average period of 7 weeks after which the females die. The maximum number of eggs laid by 1 female was 54 and the average 43. Mites transferred from *Albizzia* on to tea continue their life cycle uninterrupted but quiescent periods are slightly longer. The longevity of the adult varies somewhat but does not exceed 9 weeks under laboratory conditions. Eggs are almost elliptical .075 × .1 mm in size and bright scarlet in colour. They are stuck on singly to the under surface of the leaf and not easily dislodged. They take 13 days or nearly two weeks to hatch under laboratory conditions at St. Coombs.

The larva which hatches from the egg is a 6 legged creature, also scarlet in colour, and attains a size of approximately .15 mm. After an average feeding period of 4.2 days, it reaches a quiescent stage, which occupies about 3.3 days, then moults to give rise to the protonymph, which resembles the adult in having 4 pairs of legs instead of 3, but is only .2 mm in size. This stage lasts 7-8 days, comprising an average feeding period of 4.7 days and a quiescent period of 3.3 days, and then gives rise to the next stage, the deutonymph, which is .25 mm in size and occupies about 8 days, comprising an average active period of 4.5 days and an average quiescent period of 3.8 days. The deutonymph gives rise to the adult and the total life-cycle from egg to adult occupies 36–37 days or about 5 weeks.

The complete life history was not worked out on host plants other than tea but observations carried out over short periods on *Grevillea* and *Albizzia* show no appreciable differences in the duration of the various stages.

Previous workers in Ceylon (Green, 1900; King, 1939) have described the life history of the scarlet mite as occupying approximately 4-5 weeks. Maglitz and Cory (1953), working with *Brevipalpus australis* on orchids in Maryland, describe the life cycle from egg to adult as occupying 26 days. McGregor (1916), working with *Brevipalpus inornatus* on privet in South Carolina, found the life-cycle of this species to occupy 3 weeks in the summer, while Morishita (1954), working on the same species on the garden violet in California at a temperature of 68°F, describes the maximum period from egg to adult as occupying 33 days.

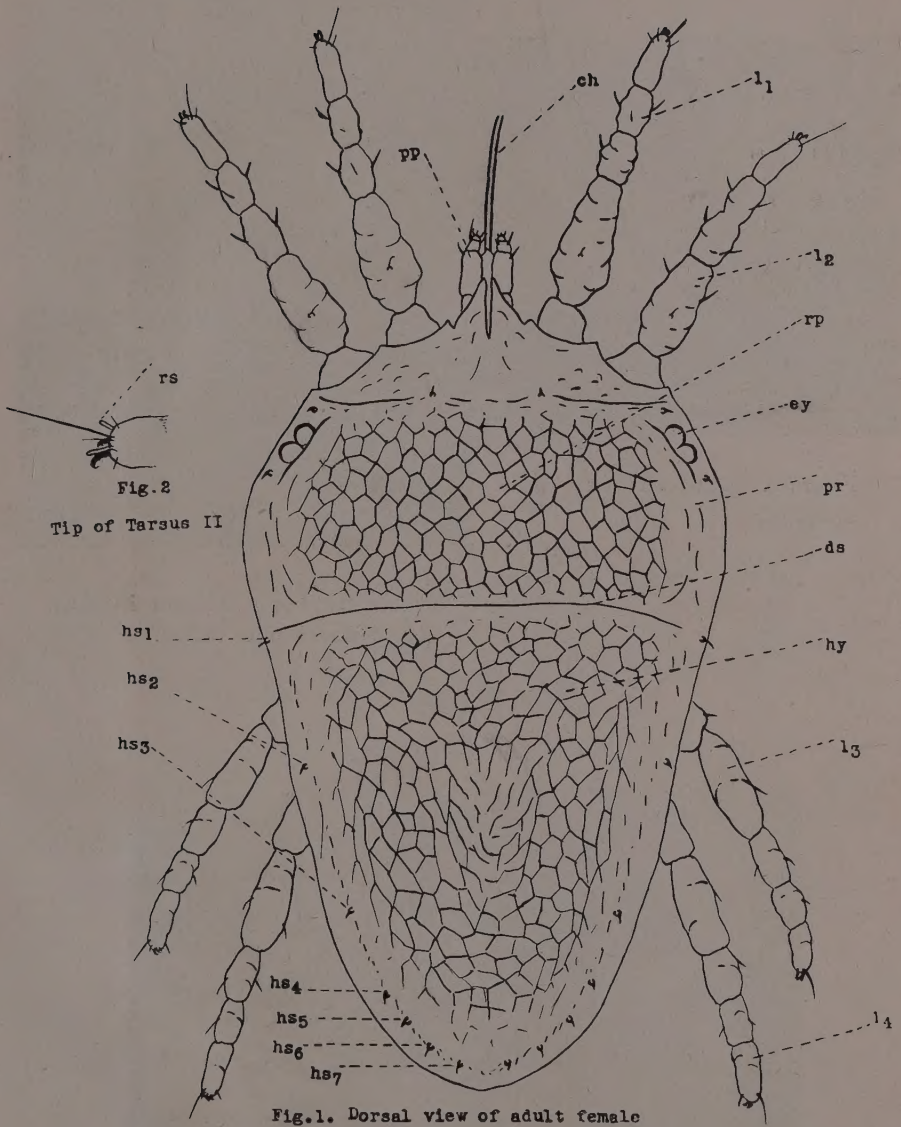

Fig.2
Tip of Tarsus II

Fig.1. Dorsal view of adult female

Figures 1 & 2. Semi-diagrammatic drawings to show details of external structure of *Brevipalpus australis* (Tucker). Very greatly enlarged.

Figure 3. Tea bush infested by scarlet mite.

Figure 4. Tea bush recovering from severe scarlet mite attack.

Figure 5. Tea bush very severely infested by scarlet mite.

Feeding habits and plant reactions.—All stages of the mite are found on the undersides of the leaves. They feed by piercing and sucking the plant tissue with their stylet-like mouth parts, the undersides of the mature leaves along the petiole and midrib being the main sites of attack.

As a result of the injury inflicted by the feeding of the mites a reddish discolouration occurs on the parts attacked, chiefly at the base of the leaf and along the midrib. Intensive, prolonged attack leads to a general darkening of the lower foliage with a scorched appearance in the basal part of the leaf and a general reduction in size of newer foliage added. There is no twisting or distortion of the foliage as is common with yellow mite damage. As the attack progresses the mature foliage drops off and, with the invasion of the younger leaves and shoots by the mite, almost complete defoliation may take place. Figures 3 to 5 show photographs of bushes in different stages of scarlet mite attack.

With the partial defoliation of the bush, the rate of production of flush becomes greatly reduced and, if such bushes are allowed to continue in plucking until the stage of acute defoliation is reached, subsequent recovery becomes problematical and the bushes often fail to survive the pruning which follows later. Both Green (1900) and Light (1928) have also recorded very serious defoliation of bushes by the mite resulting in some cases in the death of the bush. Sloan (1946) describes a comparable damage to passion-fruit vines by a *Brevipalpus* species.

Multiplication and distribution.—As compared with the more familiar yellow mite and red spider mite, the rate of population increase is relatively slow and this has an important effect on the manner of spread. Under normal conditions scarlet mite populations take about 3 years from pruning to build up to economic proportions, but much depends on the initial numbers left after light pruning as well as subsequent possible reinfestation from infested, defoliating shade trees. The intrinsic vigour of the bushes, general conditions of growth and the nature of the rainfall also have an important influence on the mite population. If factors are specially favourable, attacks of serious intensity may develop even within 6 months from a condition of apparent freedom from infestation.

The study of specific infestations from time to time has shown that one of the most potent factors contributing to the development of infestations is a regular succession of dry-weather or relatively light rainfall periods, the importance of which become accentuated or augmented by the prevalence of unlopped shade, and the adoption of exceptionally light pruning.

Overhard plucking may also seriously reduce the ability of individual bushes to withstand the attack of the mite. No direct relation has been found between copper spraying for blister blight control and the prevalence of scarlet mite.

A study of the distribution of the mite shews that it has a particular partiality for bushes on the sides of roads and footpaths. This suggests that the greater variation in temperatures which would normally prevail in such habitat niches has a definite stimulating effect on development. This is also supported by the fact that the period of most intensive development has been found to be from January to March when the degree of variation between day and night temperatures are the greatest. The comparative slow rate of spread and relative isolation of attacked bushes is most probably due to individual bush resistance, either physiological or genetic or both.

Control.—The control of any pest is normally considered from two main aspects, preventive and curative. The former is closely associated with cultural and environmental factors and is of significance in that it is useful in preventing outbreaks from occurring in the first instance, while also providing unfavourable conditions for

the development of casual or incipient occurrences of the pest in question. The curative aspect comprises chiefly the application of chemicals toxic to the pest, known in the case of mite control as acaricides, which becomes necessary in the case of outbreaks already well established when first noticed, in order to wipe out the pest without delay by direct action.

Pruning.—The normal pruning of tea is a very important mechanical means of reducing existing populations to unimportant levels of infestation, but under conditions of serious infestation it cannot by itself serve as an effective control of the pest. In this connexion clean pruning may have some advantage over light pruning, but this may not be advisable on account of the exhaustion the bush may have already suffered on account of the attack of the mite during the period immediately prior to pruning. There is also the possibility of reinfestation from *Grevillea* and *Albizzia* shade which can be quite appreciable in severely infested areas. In the pruning of infested areas it is, therefore, desirable that, though lungs or low branches should be left as is normally done, special action be taken in connexion with them so as to prevent them from being a source of infestation. This can be done effectively by the actual removal of such branches as soon as sufficient early foliage is formed, the removal being followed by an acaricidal application.

Resting.—Closely associated with pruning is the resting of the tea, which, though not strictly a preventive measure, is a very important preliminary in enabling the bushes to recover from the attack already suffered, while other control measures are in progress. Above all it enables the bushes to recover sufficient vigour to stand the normal pruning operation. If the attack has not proceeded very far, resting in itself can eventually enable the bush to carry the attack up to pruning without further defoliation or serious setback, but of course at the expense of the crop since no leaf will be removed by plucking for such a period.

Management of shade.—This is a very important factor in scarlet mite control owing to the possibility of shade trees carrying infestations of mites and by the regular shedding of leaves thus continuously reinfesting tea. The significance of this is greatest in the case of shade which is not normally lopped and defoliates continuously rather than seasonally. The periodic lopping of shade is an important method of reducing mite populations on the shade trees and should be adopted as a standard practice in chronically infested areas. Moreover, in infested areas a special lopping, amounting more or less to a pollarding of the shade, should be done, and so synchronised with the pruning of the tea that it is effected prior to pruning and within as short a period of pruning as deemed practicable under the particular conditions of the tea in question. In any case pollarding of shade must be done in the particular case of severely infested shade trees as soon as the attack is evident and such loppings should be burnt in situ.

Rain.—Another factor which appreciably reduces mite populations is very heavy and continuous downpours of rain. This applies particularly to recently pruned tea in which the frame of the bush is more or less exposed to the direct action of the rain. On the other hand, owing to the relatively protected position of the mites on the under surfaces of the leaves, comparatively normal and well distributed rain has no detrimental effect on scarlet mite populations, and in fact forcing weather as such quickly brings the attack to a head.

Trials with acaricides.—The acaricides utilized in these trials were sulphur, chlorobenzilate and karathane.

Sulphur.—This is available for application in three forms, namely a water-dispersible powder, a liquid lime-sulphur preparation and a dusting powder. Preliminary tests indicated that 1 lb. of dispersible sulphur per 25 gallons water and 1 gallon lime sulphur to 40 gallons water were the most satisfactory spray concentrations and these were therefore used in all the trials. In dusting it was found that

25-30 lb. of dust were required per acre. Sulphur has no mammalian toxicity at the strengths used. Tests carried out earlier have shown that it has a strong tainting property, which may be retained on foliage up to periods of 3 weeks after application, necessitating the discarding of the pluck for this period.

Chlorobenzilate.—This is an organic acaricide being 4, 4-dichlorobenzylic acid ethyl ester. It is a specific acaricide and is available in a commercial form as 'Akar 338' emulsifiable concentrate, containing 25 per cent. chlorobenzilate. It is also available as a 2 per cent. dust. Its mammalian toxicity in concentrations necessary for mite control is negligible and, in tests specifically carried out to ascertain tainting potentiality, it was found that tea leaf collected 1 week after application shewed no taint. Preliminary tests with various concentrations indicated a 1 in 1,000 concentration, or a .025 strength, to be the most satisfactory although a fairly good mortality was obtained with a .0125 per cent. concentration or a 1 in 2,000 strength. It is also available as a 2 per cent. dusting powder and about 25-30 lbs. are required to treat one acre.

Karathane.—This is also an organic acaricide chemically known as dinitro capryl phenyl crotonate. It is a specific acaricide and fungicide and is available in a commercial form as 'Karathane W. D.', wettable powder containing 25 per cent. of active ingredients. It is also available as a dusting powder. Its mammalian toxicity is negligible and it resembles chlorobenzilate in its nontainting properties, leaf tested 1 week after application shewing no taint in the manufactured product.

Procedure.—In the application of the acaricides, normal spraying machines as employed for blister blight control, but fitted with high-volume jet, angle-bend nozzles, were used. Each bush was sprayed individually and application directed from below so that the undersides of the foliage received a good application of spray. The applications were repeated at weekly intervals.

The major estimations of mite populations in these trials were done by counting of all stages of mites on a prescribed area. This was the area lying within an arc 1 cm from the base of the petiole of leaves from selected bushes conforming to a specific degree of attack. In each trial except the first, 3 such bushes are marked and 2 or 3 leaves taken from each bush, the leaves being chosen at random but being always the 2nd leaf below the fish leaf.

Records and results.—The population records in the case of the comparative trials are given in the tables following.

Table 1. *Trial No. 1. Sulphur and chlorobenzilate (Akar) in spray and dust form.*

Time of estimation	Mite populations found									
	Sulphur spray		Akar spray		Sulphur dust		Akar dust		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage	Number present	Percentage	Number present	Percentage
Before application	453	100%	513	100%	461	100%	574	100%	491	100%
2 days after 1st application	239	53%	259	50%	340	74%	382	67%	579	118%
1 day after 2nd application	156	34%	164	32%	229	50%	225	39%	715	146%
2 days after 3rd application	68	15%	103	20%	157	34%	216	38%	736	150%

In the 1st trial, the effect of sulphur is compared with chlorobenzilate (Akar), the two acaricides being used both in the form of an aqueous spray as well as in the form of a dispersible dust. For the sulphur spray, 'Spersul' was used at the rate of 1 lb. in 25 gallons, and for the chlorobenzilate spray, Akar at 1 in 1,000 dilution. The dusts were applied in both cases at the rate of about 40 lb. per acre. The two acaricides appeared to be more or less equally effective, but the spray treatment in each case appeared to be more effective than the dust. Only 3 applications were given and this appears to be not quite sufficient for satisfactory control.

Table 2. *Trial No. 2. Lime-sulphur and dispersible sulphur sprays.*

Time of estimation	Mite populations found					
	Lime sulphur		Dispersible sulphur		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Before application	209	100%	239	100%	191	100%
6 days after 1st application	28	13%	18	8%	248	130%
6 days after 2nd application	7	3%	11	5%	288	151%
6 days after 3rd application	3	1%	6	3%	216	113%

In the 2nd trial, a comparison is made between lime-sulphur and dispersible sulphur. For the former, 'Fernasul' was used at a dilution of 1 in 40 and for the latter, 'Thiovit' at the rate of 1 lb. in 25 gallons water. The figures represent in each case the numbers found on the basal segments of 9 leaves taken from 3 bushes. There appears to be little to choose between the effectiveness of the 2 sprays, and 3 applications gave good control.

Table 3. *Trial No. 3. Chlorobenzilate (Akar) in light and heavy spray.*

Time of estimation	Light spray		Heavy spray		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Before application	257	100%	165	100%	210	100%
5 days after 1st application	191	74%	73	44%	193	92%
6 „ „ 2nd „	160	62%	29	18%	224	107%
6 „ „ 3rd „	106	41%	6	4%	180	86%
6 „ „ 4th „	95	37%	1	1%	201	95%

In the 3rd trial a comparison is made between 2 different types of application using Akar. One application was a light spray applied from above as for blister blight control, but treating bushes individually. The other application was that of a heavy or thorough spraying of each bush both from above and from the sides. The records shew that the light spraying while reducing the numbers somewhat is not sufficiently effective to give good control even after 4 applications.

Table 4. *Trial No. 4. Chlorobenzilate (Akar) spray in two concentrations.*

Time of estimation	Mite populations found					
	Akar 1 in 1000		Akar 1 in 2000		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Immediately before application	131	100%	104	100%	98	100%
7 days after 1st application	53	40%	59	57%	124	116%
7 days after 2nd application	26	20%	70	67%	147	150%
5 days after 3rd application	10	8%	36	35%	168	171%
7 days after 4th application	6	5%	32	31%	150	153%

In the 4th trial, 2 different dilutions of Akar 1 in 1,000 and 1 in 2,000 are compared, 4 applications being given. The more dilute application of 1 in 2,000, while reducing the numbers appreciably when the population is high, appears to have comparatively little effect on the smaller populations and is insufficient for satisfactory control if a limited number of applications are given.

Table 5. *Trial No. 5. Karathane and sulphur sprays.*

Time of estimation	Mite populations found					
	Karathane		Sulphur		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Immediately before application	77	100%	129	100%	95	100%
7 days after 1st application	35	45%	57	44%	147	155%
7 days after 2nd application	19	24%	32	25%	151	159%
5 days after 3rd application	5	6%	10	8%	126	133%
7 days after 4th application	1	1%	2	2%	119	125%

In the 5th trial, Karathane W. D. at a strength of 1 lb. in 100 gallons water is compared with dispersible sulphur (Spersul) at the rate of 1 lb. in 25 gallons. The results show that Karathane is quite as effective as sulphur in reducing the mite population, 4 applications being necessary to give good control.

Table 6. *Trial No. 6. Chlorobenzilate (Akar) and Karathane sprays.*

Time of estimation	Akar 1 in 1000		Karathane 1 lb. in 25 gals.		Control	
	Number present	Percentage	Number present	Percentage	Number present	Percentage
Before application	333	100%	356	100%	236	100%
7 days after 1st application	134	40%	51	14%	164	69%
7 days after 2nd application	50	15%	10	3%	160	68%
7 days after 3rd application	25	8%	4	1%	113	48%

In the 6th trial Karathane at 1 lb. in 25 gallons is compared with Akar at a 1 in 1,000 dilution. The former appears to show some slight superiority over the latter, though this is not significant in view of the great drop in population even of the control.

In general it will be seen that although there is a very heavy reduction of mite population after the 1st application of acaricide, there is a very appreciable remnant population under field conditions until at least 2-3 more applications are given. A light application from above, as is normally given for blister blight spraying, was found to be relatively ineffective in reducing the mite population on tea in plucking, but may be effective in clean-pruned tea in the period immediately following pruning. Dusting was generally less effective than spraying, even under very good conditions for the application of dust.

Though all three acaricides are very effective in causing the mortality of active stages, resting stages and eggs are comparatively little affected. Karathane shews some superiority in this respect causing an appreciable mortality of the eggs. Contact action and residual activity in the field appears to be about the same in all cases No residual effect in the field however, can be detected 1 week after application in the case of any of the acaricides.

Recommendations for acaricidal control.—Dosage:—The recommended strengths for curative application are:—

(1) *Sulphur.* 1 lb. of dispersible sulphur in 25 gallons water or a 1 in 40 dilution of lime sulphur.

(2) *Chlorobenzilate (Akar).* 1 in 1,000-2,000 dilution of Akar.

(3) *Karathane.* 1 lb. of Karathane W. D. in 100 gallons of water or at strength of .025 per cent active ingredient.

Application:—In the application of acaricides the rows of the bushes must be dealt with individually and the application directed so as to hit primarily the underside of the mature foliage and not the superficial flush only as in blister blight control. This entails a heavy application of spray and requires more labour per unit area than that used in the case of blister blight control. About 50 gallons per acre will be required for pruned tea while at least double this quantity will be required for fully grown tea. If dusts are used about 25 lb. of dusting powder will be required per acre.

Although the cost of application of sulphur is about half that of the other acaricides, it has the disadvantage of tainting and cannot therefore be used on tea in normal plucking. Equipment used in applying sulphur should also be washed out before being used for blister blight control on tea in plucking. Nevertheless whatever acaricide is used, the application should be given after the plucking round, and even with non-tainting acaricides one week should elapse between the application of the acaricide and the following plucking.

Owing to the relatively protected position of the mites and the relative ineffectiveness of the acaricides to cause appreciable mortality of eggs and resting stages, it is necessary to repeat the application about 4 times at weekly intervals to obtain effective control.

Application of acaricides is easiest and most effective in the period following pruning. The number of applications given will vary with the intensity of the infestation but in any case two further applications will be necessary after the removal of low branches or lungs which should be done as soon as sufficient foliage has developed. If bushes had carried a severe infestation at pruning time it is also desirable that they should be stripped of any old foliage before the final applications are given. If very thorough application has been given following removal of lungs, further applications can be dispensed with. As an extra measure of precaution, however, the special applications may be augmented by the addition of a few additional applications, which may be combined with the normal blister blight spraying by adding the acaricide to the copper spray in the proper proportions. Of the sulphur preparations lime sulphur alone cannot be used in this way as it is not compatible with copper sprays.

For tea in plucking application is more difficult but is carried out on the same lines, except that light applications such as those used for blister blight spraying are not recommended. Also, if selective plucking is to be done in the area concerned, sulphur should be replaced by a non-tainting acaricide such as chlorobenzilate or Karathane. Affected bushes however should be rested for about 3 months.

The exact procedure for the routine application of control measures will vary with the condition of the tea and the intensity and distribution of the infestation. Exact schedules of application are therefore given with reference to specific conditions for guidance in the appendix at the end of the article.

DISCUSSION

The scarlet mites as compared with the red spider mites have only been of minor importance and, though recorded as occasional pests of certain economic crops, have received no very great attention with reference to ecology or control. In fact the present ravages of the scarlet mite in Ceylon appear to be economically the most significant recorded for this group of mites. Little is definitely known still of the specific reasons for the occasional build up of the mite in certain situations or what influence, if any, is exerted by biological agencies in controlling the mite population. A significant feature is the long life cycle and the presence of a long, quiescent period during each stage of development.

In Ceylon up to quite recently the mite received scant attention owing to its relatively minor nature as a pest of any importance and apart from general aspects of life history and control little detail had been studied. The present work has been carried out as a preliminary study to an intensive investigation of the bionomics and control of the mite with special reference to its significance in the cultivation of tea in Ceylon. The data obtained opens out several avenues of investigation, the most important of which are the study of the factors of resistance of the tea bush to mite

development and multiplication, the specific evaluation of weather and climatic factors in the build-up of mite populations and the reactions of these mites to new acaricides, especially those which appear to produce very specific effects while being non-toxic to possible predatory and parasitic species of insects which may occur in the tea. The use of new systemic acaricides, particularly with reference to the control of mite on shade trees, also deserves some attention, while the effects of shorter and longer cycles and suitable management and rotation of shade are likely to repay further examination.

It can, however, be claimed that in the present state of our knowledge it is possible to effect definite economic control of the pest without serious increase in the cost of production of the crop if the ravaging effects already produced by the undetected and uncontrolled activity of the pest are eliminated by immediate and intensive, curative action. If this is done serious outbreaks or attacks can be reasonably forestalled and prevented.

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APPENDIX

Schedules of application of control measures.

A. Severely infested areas in 2nd or 3rd year of cycle.

1. Throw the entire field out of plucking temporarily.

2. Lop all visibly affected (sickly looking) *Albizzia* and *Grevillea* shade and burn all loppings in situ.

3. Carry out 4 applications of acaricides at weekly intervals giving special attention to severely attacked bushes. If selective plucking is to be done, a non-tainting acaricide should be used.

4. Continue to rest the field, or, if preferred, affected bushes only, for a further two months, using during this period a non-tainting acaricide if plucking is being carried out. This application may be combined with the blister blight spraying.

B. Severely infested areas due for pruning within the year.

1. Throw the field out of plucking partially or completely and rest for 2-3 months prior to pruning.

2. Carry out the general lopping of shade and pollarding of sickly-looking or affected shade within as short a period from pruning as possible.

3. Give 2 thorough applications of acaricide after pruning within 1 week's interval of each other and another 2 applications after removal of low branches or lungs, the latter being carried out as early as feasible without causing detriment to the tea.

4. As an additional measure of control a non-tainting acaricide may be incorporated into the blister blight spray for the 1st 4 months after pruning.

C. Mild or small scattered infestations.

1. Pollard affected shade trees and lop all other shade if suitable and appropriate for lopping.

2. Mark out affected bushes by application of lime or other device and carry out at least 4 applications of a non-tainting acaricide given immediately after the plucking round.

3. Rest all treated bushes from for at least 3-4 months, but unaffected bushes in the field may be normally plucked if a non-tainting acaricide has been used.

4. Use a non-tainting acaricide in the blister blight spray for 4 months.

5. If tea is due for pruning carry out schedule of treatment under B.

Note.—If sulphur is used, leaf must not be plucked for manufacture in the same field for at least 3 weeks after last application. If blister control equipment is used for application of sulphur spray in affected areas, such equipment should be thoroughly rinsed out before being used for blister spraying in plucking areas. Other than lime sulphur other acaricides are compatible with blister spray and may be used together if desired.

THE OUTTURN OF MADE TEA TO GREEN LEAF (THEORETICAL AND PRACTICAL CONSIDERATIONS)

E. L. Keegel

In recent years the percentage outturn of made tea to green leaf* has been of considerable general interest and occupies a place in tea culture only a little way behind manufacture. One difficulty of the tea planter is to know whether the outturn he gets is satisfactory or not. Numerous current theories exist, adding confusion and giving rise to superficial conclusions, from which tangle has grown suspicion of the accuracy of figures recorded in a factory.

To most planters percentage outturn appears to be a figure which fluctuates chiefly with rainfall and age from pruning. This view is justifiable but incomplete. Few realize how wide is the scope of this subject. Several considerations have to be borne in mind and these are the subject of the present article, the purpose of which is to draw attention to the more important factors which affect outturn and the general principles underlying it.

In the first place it may be as well to explain that it is the dry matter in the leaf which constitutes the made tea. The percentage outturn of made tea to green leaf is therefore the ratio of the amount of dry matter to the fresh weight. Accordingly, the more moisture leaf contains, whether internally, or externally as surface moisture, the less the dry matter, or to put it simply, the lower the outturn. That is to say, if leaf contains 75 per cent. moisture the outturn is 25 per cent., if 80 per cent., the outturn is 20 per cent. and so on. Strictly speaking, however, the two figures do not add up to 100 because a certain amount of dry matter is lost in the withering process and possibly in the other processes as well. But as this loss is to some extent offset by the moisture in the made tea, the figure for percentage dry matter may for comparative purposes be taken to represent the percentage outturn of made tea to green leaf.

The moisture content of a plucked tea shoot varies considerably. Not only is there a difference between the fresh leaves and stalk, but some leaves contain more moisture than others, some stalks are more succulent than others, and the proportion of stalk to leaf also varies. To these causes must be added the external wetness of the leaf, which varies not only according to the degree of wetting but also to the size of the leaf. The internal moisture of the leaf itself is influenced by its morphological properties, age from pruning, and climatic and weather conditions. Hence it is quite impossible to decide whether the variation in the moisture content of flush is due to any particular cause. For example, the percentage moisture of surface dry flush may be as low as 68 per cent. or as high as 78 per cent. In wet weather it may still be 78 per cent. or reach the abnormally high figure of 85 per cent. A 78 per cent. moisture content may be associated with 'dry' leaf or wet leaf, or again it is quite possible for flush with a high proportion of stalk to have a moisture content

* "Leaf" is used in a general sense in this article, meaning the leaves and stalk from a freshly plucked shoot, unless a clear distinction is drawn between the two terms.

higher than 78 per cent. even though it may be perfectly dry on the outside. It is quite fallacious to assume that green leaf free from surface moisture should yield a constant outturn.

The factors that exercise the greatest influence on the moisture content of a plucked shoot are therefore:

(1) its composition,
(2) the weather,
(3) age from pruning.

These may or may not be interrelated, but an examination of each in turn will be helpful in throwing some light on a complex and controversial question.

Composition of the Plucked Shoot.—This is closely related to type of leaf and rate of growth, the latter being governed by environment and age of the bush from pruning. The cumulative effect of all these factors is to alter the proportion by weight of stalk and also its moisture content.

It is a current impression that flush from 'young' fields generally contains a higher proportion of stalk than that from 'old' fields but in the case of bushes of poor growth the plucked shoot may actually resemble one from a bush due to be pruned. Table 1 shows the variation and also the respective moisture contents obtained from the more stalky and less stalky flush gathered at the same plucking from a field with mixed 'jats'.

Table 1. *Relative proportions and moisture contents of stalk and leaves in flush from a 'young' field.*

Age from pruning	Sample	Proportion by fresh weight		Moisture content		
		Stalk	Leaves	Stalk	Leaves	Whole shoot
5 months	(*a*) more stalky shoots	28%	72%	85%	76%	78½%
,,	(*b*) less stalky shoots	14%	86%	83%	76%	77%

From observations made on the distribution of moisture in a shoot, it has been established beyond all doubt that the stalk contains more water than the leaves but there does not exist any sort of relationship. The difference in the moisture content can be as much as 20 per cent. or as little as 5 per cent. Table 2 gives some figures for the moisture contents in the leaves and stalk of flush. (T. R. I. Bull. 9, p. 11.)

Table 2. *Variation in the percentage moisture content of stalk and leaves of a flush.*

Sample	MOISTURE CONTENT		
	Stalk	Leaves	Difference
1	91%	71%	20%
2	78%	73%	5%
3	83%	74%	9%
4	81%	73%	8%

These figures, it must be noted, were obtained with a fine pluck of 2 leaves and a bud. It is thus evident that the variation in the outturn of made tea to green leaf cannot be gauged merely from the standard of plucking. Apart from a variation in the moisture content of the main components of a shoot, the stalk and leaves themselves do not always exist in the same proportion to each other, as shown in Table 1. Flush from rapid growth, for instance, will have stalk of a longer length than say banji flush, but not necessarily of a higher moisture content. The extra length of stalk, however, in the former will naturally increase the moisture content of the whole shoot.

The variation in the size of the leaf does not appear to exert such a marked influence as stalk, except when it is wet. In wet weather, the moisture content of a stalk varies little but the leaves, on account of their ability to retain surface moisture, make an important contribution. It is not perhaps realized that a tea leaf in its maximum condition of wetness can hold as much as 30 per cent. surplus water or more. Therefore, the bigger the surface area of the leaf the lower the outturn in wet weather, all other conditions being equal. To understand the significance of surface moisture the following example is given. Assume that, prior to wetting, the stalk contained 83 per cent. moisture and the leaves 76 per cent. moisture and that the proportion by weight of stalk was 15 per cent. A plucked shoot of this description would have a moisture content of 77 per cent. Now if this shoot is thoroughly wetted the leaves would retain 30 per cent. of water but the stalk practically nil. The moisture content of the stalk would therefore remain unchanged, but that of the leaves would increase to 81.5 per cent. The final moisture content of the shoot would then be approximately 82 per cent. That is to say, the outturn would drop from 23 per cent. to 18 per cent. Larger leaves capable of holding more surface moisture would cause a further reduction.

Another and interesting point of note is that in a period of drought, as experienced in some upcountry areas, the moisture content of the leaves may actually fall to 66 per cent. whilst that of the stalk may not show such an appreciable change. The standard of plucking, jat and age from pruning will, accordingly, considerably influence the maximum percentage outturn recorded on an estate. It is for this reason that two neighbouring estates under exactly the same weather conditions may obtain dissimilar outturns on a single day.

The error which can be introduced by ignoring the variations in the composition of the plucked shoot is no small amount and the necessity for considering it in the examination of data for outturns is clear. The two following examples will give a fair idea of how stalk, in particular, affects outturn.

Example 1:—Assume proportion of stalk by weight is 20 per cent., and moisture content of stalk and leaves 86 per cent. and 76 per cent. respectively. The percentage dry matter of the whole shoot will then be equal to

$$20 \times \frac{14}{100} + 80 \times \frac{24}{100} = 22 \text{ per cent.}$$

Example 2:—If the proportion of stalk was 30 per cent., the percentage dry matter by a similar calculation would be 21 per cent. Under actual practical conditions it would be still less because generally an increase in the proportion of stalk is associated with an increase in its moisture content.

From data collected on St. Coombs the proportion by fresh weight of stalk in a plucked shoot varies from about 15 per cent. to 35 per cent. Expressed as percentage of the dry weight of the shoot the relative proportion of the stalk therefore fluctuates between 10 per cent. and 25 per cent. or thereabouts. Since stalk contains considerably more moisture than the leaves, the contribution it makes to the outturn is indeed significant.

The Weather.—The part played by the weather is much more complicated than it appears at first sight. It is not merely a question of the total rainfall or the number of hours of sunshine recorded; the state of the weather preceding plucking and during plucking has to be considered as well. Leaf plucked on a dull, cloudy day, for instance, would have a higher moisture content than leaf plucked following a long period of drought. During a very dry spell rapid transpiration occurs, quicker than the rate at which the bush can take up moisture from the soil, and this will result in a considerable reduction in the moisture content of the leaf. Under humid conditions, as frequently experienced in the low-country, the leaf even though exposed to the sun's rays would lose relatively less moisture and so contain more moisture. Further, in a very wet spell it is not only the surface moisture on leaf which affects the percentage moisture content but the internal moisture as well. Thus the heaviest rainfall at the end of an extremely dry spell will not lower the percentage dry matter to the same extent as continuous wet weather normally experienced in up-country western districts during the south west monsoon.

The two points therefore to be considered in examining the influence of weather are (*a*) internal moisture (*b*) external moisture. They cannot be considered apart because the internal moisture of leaf, whether wet or dry, is not constant. From the evidence available this may vary from 78 per cent. in wet weather to 69 per cent. in dry weather. External moisture may be as much as 30 per cent. of the total weight, depending on the weather and the size of the leaves. In this condition of extreme wetness the total dry matter of a plucked shoot may be reduced to 16 per cent. (84 per cent. moisture). Even a slight deposition of moisture on the surface of the leaf is sufficient to cause a noticeable reduction in the percentage dry matter. For example, assume that as a result of slight wetting by rain, mist or dew the weight of a flush increases by only 5 per cent. and that it had initially 76 per cent. moisture (or 24 per cent. dry matter). It would mean then that 100 lb. of such leaf would have increased in weight to 105 lb. Now if this were manufactured the product would still weigh 24 lb. The percentage outturn of made tea to the wetted leaf would thus be $\frac{24}{105} \times 100 = 22.8$, a drop of 1.2 per cent. This example is striking enough to show the marked influence of surface moisture on percentage outturn. Roughly speaking, percentage outturn drops 1 per cent. for every 4 to 5 per cent. increase in weight of leaf brought about by surface moisture.

In practice, the relation between the physical state of the leaf and percentage outturn appears to be as shown in Table 3.

Table 3. *Relationship between the physical condition of green leaf and percentage outturn of made tea.*

Condition of leaf	Percentage outturn of made tea to green leaf.
Surface dry	22 to 28
Slightly wet	21 to 22
Wet	19 to 21
Very wet	17 to 19

This table should not be used indiscriminately since the composition of the plucked shoot is another factor.

A second important point to be taken into consideration is that the variation in the percentage outturn of wet leaf need not be entirely due to a variation in the amount of surface moisture. It is also dependent on the internal moisture content, which itself varies according to the weather. For example, assume two lots of identical leaf, one plucked during continuously wet weather and the other in a shower following a dry spell. The internal moisture content would not be the same in both cases.

Suppose the former was 78 per cent. and the latter 76 per cent. and that surface moisture in each case was 10 per cent. of the total weight. The percentage outturns would then by a simple calculation be found to be 20 per cent. and 22 per cent. respectively, although, it will be noted each was wetted to the same extent.

To such complex factors must be added the variation of the weather in the course of plucking. The same amount of rainfall may be recorded on two successive days but the outturns may be entirely different. A few hours of sunshine or a variation in the intensity and distribution of rain will bring about quite a marked change in the moisture content of the plucked leaf and so alter the daily outturn. This aspect is well illustrated by the figures given in Table 4, taken from the results obtained from an experimental block at St. Coombs for three typical seasons.

Table 4. *Variation in percentage dry matter of the leaf in the course of plucking.*

	PERCENTAGE DRY MATTER		
	1 Dry weather	2 S. W. monsoon (continuous rain)	3 N. E. monsoon (morning sun and afternoon rain)
Morning pluck	23	19	20
Noon „	25	19	24
Afternoon „	27	19	19
Total for the day	25	19	21

In the first example the increase in the percentage dry matter towards the end of plucking has been caused by transpiration losses. The steady figures in the next are easily explained by the effect of continuous rain and absence of sunshine. The fluctuations in the third have been due to deposition of dew the night before, a bright morning and the advent of rain in the afternoon during plucking.

These figures, besides showing the effect of weather during the course of one plucking, focus attention on quite another important aspect of this question, namely, the variation of the total percentage dry matter for the day. It will be noted that in examples 2 and 3 the total for the day is 19 per cent. and 21 per cent. respectively, but the rainfall recorded between the hours of 8-30 a.m. and 3-30 p.m. was actually less in the former case. It may be of interest to mention that only 0.05″ of rain fell on the day 19 per cent. was obtained whereas the higher figure of 21 per cent. was associated with 0.70″. Why a simple formula cannot be worked out to express quantitatively the correlation between rainfall and percentage outturn is obvious and therefore makes further comment unnecessary.

Another and most significant question, which emerges from considerations of the moisture content of green leaf, is the practice on some estates of permitting in the factory a system of allowance for surface moisture in wet leaf, with a view to either insisting on a fixed outturn or obtaining a flattering outturn. It has already been shown that the moisture content of surface dry leaf plucked directly from the bush is not a constant figure. It is therefore evident that, even if the moisture content of wet leaf is determined, it will be impossible to say with any accuracy how much of that water is due to surface moisture alone. How much bigger must be the error to rely upon an empirical correction to counterbalance surface moisture? If too much is deducted the outturn will be too high while if too little is taken away from the actual weight of green leaf received for manufacture the outturn will be lower than the figure aimed at. Since the figure for percentage outturn can be made to be almost anything one pleases by altering the weight of green leaf, any system of allowances is not only unsound but subject to abuse as well. The folly of such a procedure has now come to be realized by many estates and the sooner actual outturns are recorded the better.

Age from Pruning.—One very serious difficulty, always present when attempting to assess the effect of the age of leaf from pruning on an estate, is caused by the general type of weather experienced at the time the observations are made. Figures for percentage outturn will be entirely untrustworthy if for example 'old' and 'young' leaf have been plucked at different times of the year, and on different days, as is the case on every estate. Other errors introduced are the inherent differences which exist between one field and another in relation to rate of growth and the composition of the flush.

It is quite impossible, even should careful data be recorded from say two similar fields of different ages, to know precisely how much of the difference noted between outturns is due to a difference in age or a difference in weather conditions or both. If they are plucked on different days, comparison of made tea outturns will be an useless undertaking. The weather is not consistent from one round to another, let alone during the course of plucking from morning to evening. It is obvious, therefore, that an accurate examination can be made only on the same type of leaf and at the same time of the day.

Table 5. *Effect of age from pruning on percentage dry matter for each pluck.*

Date of Pluck	PERCENTAGE DRY MATTER		
	Pruned September 1931	Pruned May 1932	Difference (to nearest ½%)
22-10-32	22.1	21.0	1
31-10-32	20.7	20.7	0
9-11-32	21.9	21.5	½
18-11-32	22.5	21.7	1
27-11-32	22.6	21.9	1
6-12-32	23.7	22.3	1½
15-12-32	20.6	20.4	0
24-12-32	23.7	22.4	1½
2- 1-33	25.1	23.6	1½
11- 1-33	22.9	22.0	1
20- 1-33	22.5	21.3	1
29- 1-33	23.0	21.8	1
7- 2-33	23.7	22.9	1
16- 2-33	25.8	23.9	2
25- 2-33	24.4	23.0	1½
6- 3-33	25.8	24.7	1
15- 3-33	26.3	24.6	2
24- 3-33	25.4	23.6	2
2- 4-33	25.0	23.7	1½
11- 4-33	23.5	21.9	1½
20- 4-33	25.6	22.6	3
29- 4-33	23.7	21.9	2
8- 5-33	22.4	21.6	1
17- 5-33	20.4	20.4	0
26- 5-33	19.7	19.8	0
4- 6-33	20.3	19.8	½
13- 6-33	22.2	22.0	0
22- 6-33	20.7	19.8	1
1- 7-33	20.6	21.6	-1
16- 7-33	23.6	22.9	1
19- 7-33	22.0	22.3	0
28- 7-33	23.9	23.3	½
6- 8-33	23.6	20.8	3
15- 8-33	22.8	21.5	1½
24- 8-33	21.3	20.7	½
2- 9-33	20.3	19.7	½
11- 9-33	24.4	23.6	1
20- 9-33	22.9	22.0	1
29- 9-33	21.9	22.0	0
8-10-33	21.1	20.6	½
17-10-33	22.0	21.0	1
26-10-33	23.8	22.8	1

Records from a pruning experiment, conducted by the Plant Physiology Department in 1931 and designed solely to study the effect of time of pruning on yield, provided some useful information. By calculating the percentage dry matter for two areas pruned at different times of the year the effect of age from pruning was estimated to within a reasonable degree of accuracy. Since treatments were replicated and plucking carried out on identical days, errors due to difference in weather and leaf were eliminated. Results were therefore strictly comparable. Although the difference in age was only 8 months, one area being pruned in September 1931 and the other in May 1932, differences in the percentage dry matter (percentage outturn for all practical purposes) were noted. The variation in the percentage dry matter is shown in Figure 1. Besides showing the effect due to age from pruning over a period of 3 years the graph shows the rise and fall in level caused by weather changes.

At first sight the general character of the fluctuations seems to follow a definite pattern but on closer examination it will be seen that the difference in outturn is only marked at the beginning of the pruning cycle, gradually becoming insignificant towards the end. It thus appears that, after a certain age from pruning, leaf can be expected to give more or less the same outturn as much older leaf. The prevailing idea that the older the bush the higher the outturn is thus not entirely confirmed by these results. It is evident, however, that in the early stages of a pruning cycle leaf quite definitely gives a lower outturn, which according to this graph can be as much as 2 per cent. on a monthly basis. An analysis of the figures obtained for each pluck for the first year of plucking of the area pruned in May 1932 compared with the other gives a clearer picture of the effect of age from pruning. Table 5 shows the variation.

Another interesting feature disclosed by the graph is that, though the general trend is for the percentage dry matter to be inversely proportional to rainfall, it is not always necessarily so. For instance, in October 1933, during which the rainfall was 16″, the monthly outturn was not much different from that in September 1934 when only 3″ was recorded. It will also be noted that the lowest monthly outturn in the whole cycle was 20.6 per cent., which was recorded in a month during which only 9.5″ of rain had fallen, whereas in the previous month, during which the rainfall was as much as 36.4″, the outturn was actually slightly higher. These figures provide a good example of the absence of any strict relationship between rainfall and outturn.

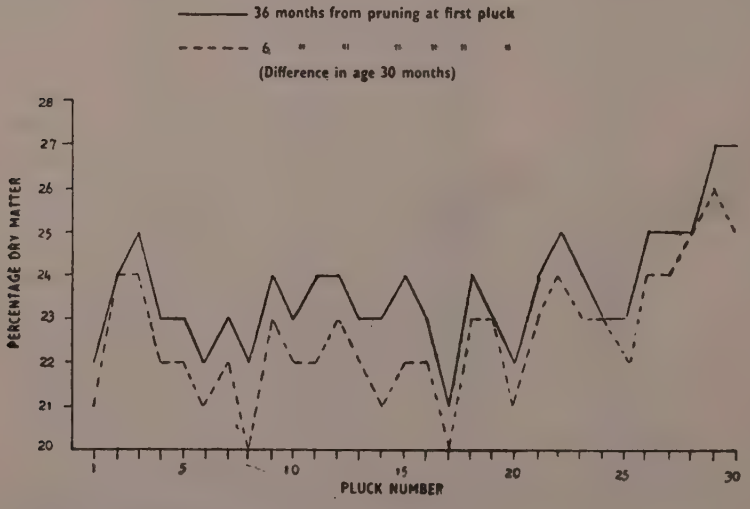
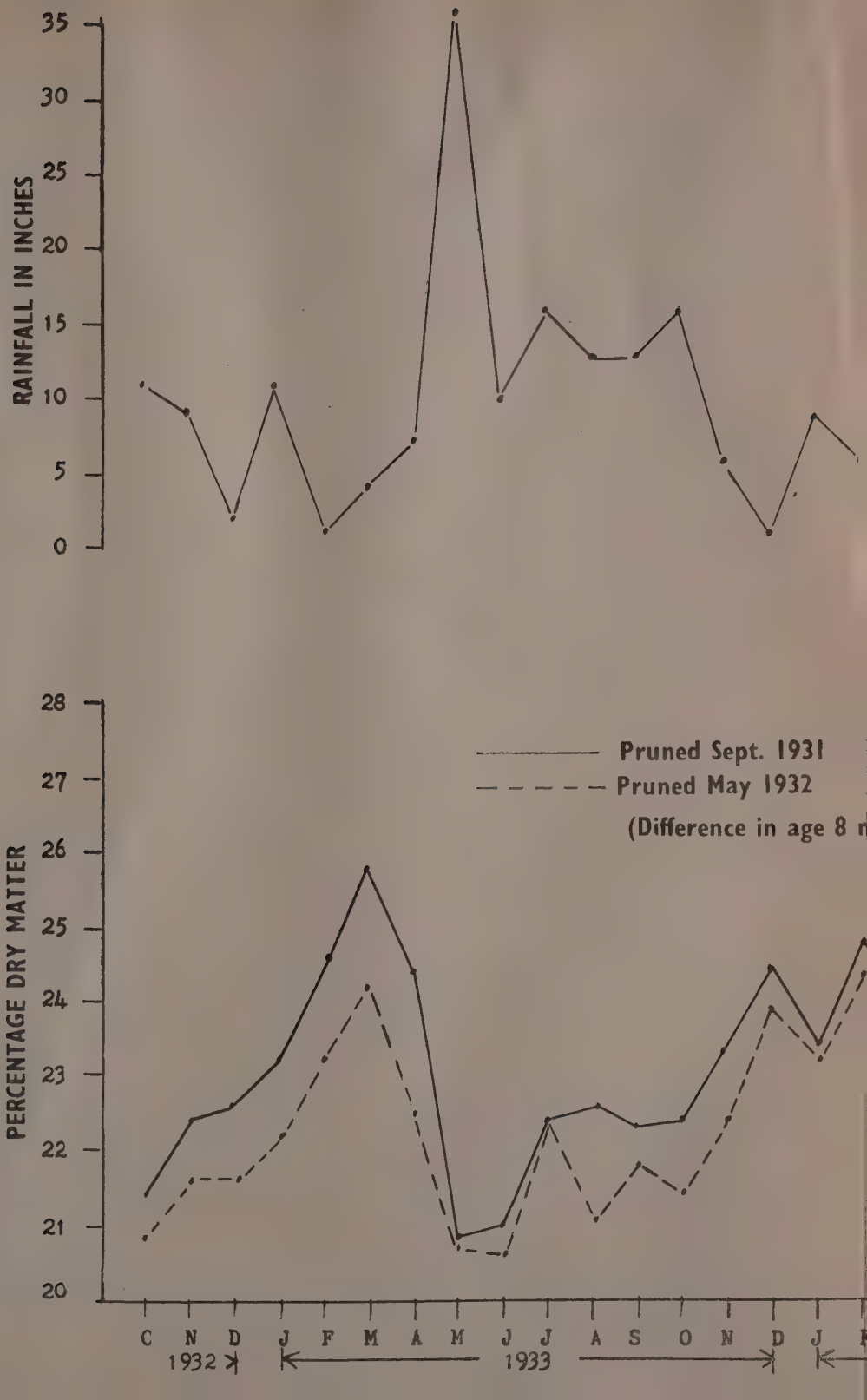
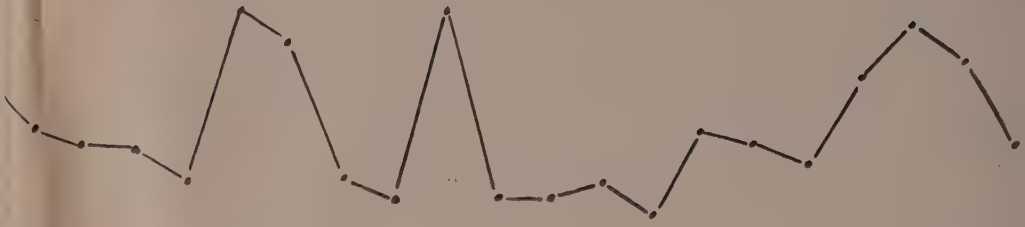


Fig. 2. Effect of age from pruning on percentage dry matter of each of 30 consecutive plucks (Clonal material).


RAINFALL IN INCHES
35
30
25
20
15
10
5
0
PERCENTAGE DRY MATTER
28
27
26
25
24
23
22
21
20
Pruned Sept. 1931
Pruned May 1932
(Difference in age 8 m
C N D J F M A M J J A S O N D J
1932
1933

RAINFALL



B months)

y matter for a period of 3 years (Graph also shows seasonal variation)

From observations made for each pluck on clonal material, which differed in age by $2\frac{1}{2}$ years, further proof was obtained that mature leaf contains a higher percentage of dry matter, but not as high as generally believed. The maximum difference noted was 2 per cent. Figure 2 represents the percentage dry weight of the leaf in question for 30 consecutive plucks of 500 bushes comprising 47 different clones.

The seasonal fluctuations are again prominent and it was observed once more that the increases and decreases were not in the same proportion as the rainfall. These investigations do show, however, that on the whole age from pruning has a definite effect on the outturn of made tea to green leaf but the difference in outturn may be anything from 0 to 3 per cent. There is no evidence to indicate what causes this variation.

Going over the ground covered so far it is clear why golden rules cannot be laid down. In addition to the many complex factors which have been discussed there are others which make themselves felt in the course of manufacture. The more important of these are:—

(*a*) loss in dry matter during withering,

(*b*) final moisture content of the made tea,

and (*c*) standard of plucking.

Loss in Dry Matter during Withering.—According to Evans (T. R. I. Bull. 9, p. 7) "The actual dry weight of the leaf diminishes according to the time spent in withering and if the wither is very slow such as occurs in wet weather this loss of dry matter is considerable". The figures he obtained are given in Table 6.

Table 6. *Effect of period of withering on dry matter.*

Period of withering	weight of dry matter
Fresh leaf (100 lb.)	18.8 lb.
20 hours	18.5 lb.
40 hours	18.0 lb.
48 hours	17.6 lb.

Up to 20 hours the loss in dry weight is 0.3 per cent. but on prolonging the wither the loss increases to a significant figure of 1 per cent. Calculated in terms of tea made, or crop, these figures are equivalent to a loss in crop of up to about 1 per-cent. for short withers and 5 per cent. for long withers, and cannot be considered negligible.

Since it is respiration which gives rise to the loss of dry matter there is reason to believe that temperature and physical condition of the leaf also play an important part. High temperatures and sappy leaf can therefore be expected to increase the loss of dry matter and thus reduce the outturn of made tea to green leaf.

Final Moisture Content of the Made Tea.—The hygroscopic properties of tea are well known. Under the conditions obtaining in any factory, tea must absorb moisture after it is fired. The amount it will take up before it is packed will depend on the period of exposure during sifting and picking and of storage in the bins. It is perhaps not realized that for an increase of only 2 per cent. in the moisture content of the tea the percentage outturn of made tea to green leaf inevitably increases

by approximately 0.5 per cent. This is no insignificant increase considering that estates as a rule attach undue importance even to small differences in the decimal fraction of an outturn figure. If final firing prior to packing is carried out the outturn is lowered.

In examining figures for outturn it is therefore essential to know whether they are computed from (*a*) fired tea (*b*) sifted tea (*c*) stored tea or (*d*) tea that has been final fired.

Standard of Plucking.—The product obtained after firing comprises fibre, fluff, stalk and waste tea, components which are removed in the sifting operation. Made tea as it is understood to be, consists of what is left. It is plainly clear therefore that the final figure for percentage outturn is dependent on the amount of refuse discarded, which may be negligible for a very high standard of leaf but as high as 6 per cent. for coarse plucking.

To sum up, weather is undoubtedly one of the important considerations but the other factors are equally important and must not be lost sight of. It is for this reason that it is impossible to pre-determine the percentage outturn of made tea to green leaf by determining the moisture content of leaf arriving at the factory. In any case it is not practicable since each sack of leaf will have to be considered if a representative sample of the day's leaf is to be taken. Accordingly, percentage outturn is a figure most difficult to check. The magnitude of such an undertaking will be better appreciated by a study of the figures given in Table 7. These have been abstracted from records of manurial experiments carried out under the supervision of the Plant Physiology department.

Table 7. *Variation in percentage dry matter of green leaf.*

Age from pruning		PERCENTAGE DRY MATTER				
		A	B	C	D	E
4-5 months	Minimum	20	19	19	20	18
	Maximum	26	28	26	26	27
6-12 months	Minimum	16	18	17	17	17
	Maximum	26	30	26	30	25
36-48 months	Minimum	—	17	16	18	15
	Maximum	—	28	27	27	28

The considerable deviations shown in the foregoing table are not only the result of weather conditions but also of the character of the plucked shoot. A number of causes may be all operating together to give the fluctuations noted. It will be of interest to note that tipping leaf may very well give an outturn as high as mature leaf, as these figures reveal.

In conclusion, it only remains to give a brief summary of actual outturn figures recorded at St. Coombs Estate and the extent of the variations. The lowest daily outturn obtained has been 17 per cent. and the highest 29 per cent.; the lowest monthly outturn 20 per cent. and the highest 28 per cent.; the lowest annual outturn 22 per cent. and the highest 23½ per cent. No useful purpose will be served by giving further details, but a frequency distribution of outturns for a period of 12

consecutive months may interest the reader. This is set out in the form of a diagram, Figure 3, in which each column is proportional in height to the number of days a particular outturn has been recorded.

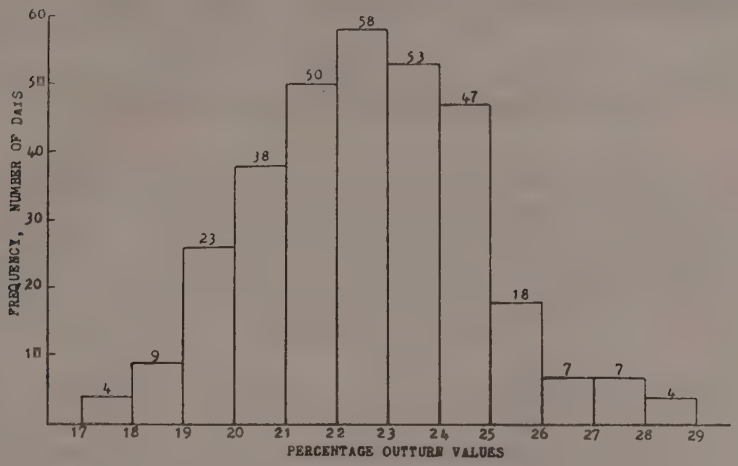


Fig. 3. Frequency distribution of daily percentage outturn for one year. (Total rainfall 120″).

The total rainfall for the period in question was 120″, the highest monthly rainfall being 36″ and the lowest 0.5″. Total number of wet days was 260.

The main things to notice about this diagram are that there is a peak showing a tendency for outturns to be concentrated between 20 per cent. and 25 per cent. and that outturns below and above these values are rare. All these figures and those quoted in the preceding paragraph have been calculated from 'graded' tea (broken mixed included) and leaf from which no deductions have been made. Refuse tea has not been included.

It may or may not be possible to generalize from the results obtained at St. Coombs, but it would appear highly improbable from this evidence and what is available from estates in different districts that any average estate would be able to declare an annual, *true* outturn varying much from 22 to 23 per cent. In certain dry areas in Uva, where at times the annual rainfall does not exceed 50″, an annual outturn close upon 24 per cent. may not be unusual, whilst in the very wet districts with an annual rainfall approaching 200″, an outturn of 22 per cent. may be difficult to obtain. However, in contemplating the final figure arrived at, the circumstances under which it has been recorded must be duly considered, because it is all too easy to forget the way in which it is derived.

I should like to express my indebtedness to the Plant Physiology department for some of the figures published in this article.

GOTUKOLA—AS A COVER CROP FOR TEA*

S. S. Perera

(Korahilagoda Estate, Telijjawila, Matara)

I have read with interest articles by Mr. Fernando and Mr. Mollison, in the *Tea Quarterlies* of June 1951 and June 1952, on cover crops for tea. In this short account I wish to refer to a "weed" or "cover crop"—whichever you like to call it—gotukola, (*Hydrocotyle asiatica* or *Centella asiatica*). The publication "A manual on the Weeds of the Major Crops in Ceylon"—Department of Agriculture—July 1951, has to say this on gotukola: (1) prevents erosion, (2) shallow rooted, (3) marked competitor in tea, in all but rich soils, if not frequently controlled by forking.

After ten years I can agree with (1) and (2) but not with (3). I have encouraged the growth of gotukola on this estate—elevation 300 feet, annual rainfall 110 inches average—for the past 10 years. In 1945 there were only isolated patches of gotukola in the different fields; today there is a nice green cover of gotukola throughout the estate. The average yield in 1945 was 626 lbs. per acre; for 1954 and 1955 it is nearly 1,100 lbs. Regular manuring is carried out as recommended by the Tea Research Institute.

Weeding is done only round the bushes, and weeding costs have thus been reduced. No silt finds its way into the drains and attention to keep these in order is negligible. Forking is a light task for the labourers since there is no hard pan of earth to be broken, and the soil remains moist throughout the year. Even after forking very little wash takes place since the loose earth is held together by gotukola. It does not form a thick mass as does *Desmodium triflorum;* it is shallow rooted and can be weeded out quite easily. I feel the increase in crop is to a great extent due to the moist soil conditions throughout the year and the conservation of the top soil. I have allowed gotukola to grow on the paths and drains as well. After manuring the gotukola in the centre of the rows withers, but quickly recovers.

I encouraged the growth of gotukola in the new clearings here, weeding only round the plants, which at the time looked very green and healthy. These clearings, now in their third year of plucking, will give 1,000 lbs. per acre.

I have not spent any money planting gotukola. Isolated patches have been allowed to grow. The tea here is about 25 years of age. Previously this land grew citronella for about 20 years without any manure at all. From this small experiment I think I could say that gotukola is not a competitor in tea, even on bad soils.

Some years ago Dr. Reginald Child wrote in the Times of Ceylon, "Gotukola—New Light on an Old Drug". He said gotukola was one of the best known and longest recognised medicinal plants in the east—being recommended to people suffering from catarrh. It is also greatly valued as a vegetable in village homes, and finds a ready sale at all market places in this area. Dr. A. W. R. Joachim has found

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*The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.

that fresh gotukola leaves have a moisture content of 84.3 per cent., protein 2.9 per-cent., mineral 2.1 per cent., fibre 1.8 per cent., fatty substances 0.03 per cent., and carbohydrates 8.6 per cent. Gotukola can serve as a crop in our major crops, as a medicine and as food.

It would not be wise to put down the very large increase in crop to gotukola alone, but I can definitely say it has made a big contribution towards the increase, and yields have been increasing every year since 1945.

I have to thank Mr. N. H. Rumbelow of Hatherleigh Group, Rakwana, my Visiting Agent, for the support I received in carrying out this small "experiment".

REPLANTING IN THE LOW-COUNTRY AND ASSOCIATED PROBLEMS*

T. E. Walter

I much appreciate having been asked to address your meeting to-day—especially because as a speaker here I find myself in very illustrious company. I refer not only to the Hon. the Minister of Finance who is addressing you to-day, but also to the speakers at some of your recent meetings including the Hon. the Minister of Transport and the Prime Minister himself. It is also gratifying as being an indication that you are once again concerned with increasing your yields, and I recall that only recently you were all more concerned with reducing them!

Now as you know already, I came over to this district several weeks ago to make my own observations as to what the particular problems of current importance are. I am glad to have had this opportunity of meeting many of the planters in the district, and would like to record my thanks to Mr. Abeygoonewardena for arranging such a comprehensive tour for me, including as it did a very fair cross section of the estates in the district; actually 7 estates were officially included in this itinerary, not to mention several others that I included for good measure. What follows is based entirely on what I saw in this district—the main theme being replanting and associated problems with special reference to the worst and most difficult areas. I have also included a section on the various pests which are causing concern at the moment in the district.

Low-Country Sub-Station.—Before starting this review, however, I would just like to take this opportunity of saying a few words regarding the latest developments in connection with the low-country sub-station. The present position is that plans made some time ago to enlarge the scope of our activities are being implemented along the following lines:—

(1) Further V.P. Expansion.—An offer of a large block of flat and very uniform old rubber land in the Kalutara District was received in October of last year, and negotiations regarding the lease of 25 acres of this land have now reached the final stages. Approval in principle with this scheme was given at a recent meeting of the T.R.I. Experimental and Estate Committee, at which representatives of low-country districts were present. I would add that several other possible alternatives had been investigated, but in every case the land was found after further inquiry to be unsuitable. It may also be of interest to this district to note that a further clonal proving trials area is being established at Peradeniya where the Department of Agriculture has been very co-operative.

(2) Shot Hole Borer.—Experiments are continuing in the Ratnapura district under the supervision of Mr. Austin and his assistant. Further plans are being made for setting up the necessary laboratory for the intensification of this work, so that the Ratnapura district may become the centre of what amounts to an entomological sub-station. In addition a senior Entomologist has been seconded to the T.R.I.

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*Address given to the Morawak Korale Planters' Association on 26th August, 1955.

from Messrs. Fison's Pest Control Ltd. for a minimum period of 2 years to work on the shot hole borer problem; a bungalow has been put at his disposal near Ratnapura and his additional services should be of great value.

(3) Manuring.—A further manuring experiment, entailing the use of 162 plots, has been laid down on Endane Estate to investigate the requirements of high yielding low-country tea. To start with 3 levels of nitrogen and 3 levels of potash are being applied (phosphate levels remaining constant): a third treatment will be added later to enable the effects of some other elements such as magnesium to be investigated. An assistant has been specially recruited for this experiment.

New Plantings.—Coming now to my survey of this area, I would like to start by saying a few words concerning new plantings, with particular reference to the danger of indiscriminate opening up of jungles as is taking place on some estates. Now on my recent tour I was amazed at the phenomenally steep slopes which have recently been cleared, and which many of you are now trying to plant up. In fact I saw some new clearings whose slope in parts could not have been less than about 75° or even more. My first photograph* illustrates graphically the results of the usual policy of trying to grow tea on every available square yard of land, and before going any further, let me say that my following remarks in this connection should not be taken as implying criticism of the careful work which has obviously been done on this clearing. The particular estate which provides the subject for the photo was one of those I looked at (unofficially) in passing, so I am afraid I cannot give you any details of the clearing. There are, however several points which I want you to notice particularly,—firstly the establishment of albizzia wind protection belts down the middle part, and secondly the fact that on the really steep part in the middle it is extremely difficult to pick out any tea plants at all! The inference from this is that the land in question would have been put to far better use if a strip of jungle had been left on the steepest part, both from the point of view of preventing soil erosion and as an effective wind-break. In fact the results achieved on such precipitous slopes here and elsewhere merely indicate that it is not worth while trying to plant them up with tea.

By way of enlarging on this point; as you know it is an established principle of Government policy not to alienate land with a slope of more than 45°. In the case of privately owned land, however, there is apparently no limit at all to the slope which many proprietors consider suitable for growing tea, in spite of the obvious practical difficulties of plucking such areas. In putting forward the suggestion which I have just outlined, I am of course fully aware that one often finds patches of excessively steep land occurring in blocks which are otherwise suitable for tea, and obviously small patches of jungle cannot be left scattered about; the treatment I suggest for such patches is that they could be put to better use by growing Guatemala grass instead, not only to provide a really effective soil binder but also as a permanent source of organic matter for thatching and soil rejuvenation, which aspects I shall be enlarging upon later.

I have given priority to this question of correct land usage as it should obviously be the first point to be considered in any large scale scheme for the expansion of the tea industry by new planting, bearing in mind firstly that this district is pre-eminently suitable for the growing of tea, and secondly that there is no land shortage here. This plea for correct land usage should be taken in conjunction with the necessity for doing everything possible in the hill areas to control soil erosion and to limit the annually recurring floods which menace the lowlands. It is of course customary to blame these floods like most other things on the Government, who in turn blame the tea estates for opening up jungle land; they in turn point to the small

*It is regretted that it has not been found possible to reprint any of Mr. Walter's photographs. Ed.

holders who in turn pass the baby on to the Government, thus completing the circle. The small holders are now becoming increasingly aware of their responsibilities in this sphere, owing largely to the recently introduced system of grants for terracing and draining, so the alibi held previously by estates is no longer effective.

Lest you should think that I have been unduly critical of the methods adopted by big land owners in opening up land, I have much pleasure in showing some photographs taken on the 1954 new clearing on Kobomella Estate, which is undoubtedly the best I have seen anywhere. In fact, if I had any prizes to give, I would unhesitatingly award the first prize to the Superintendent of this estate. These photos illustrate far more graphically than any verbal description of mine what should be done on all steep slopes where it is not enough to be satisfied merely with planting on the contour. On this clearing the slope varies between about 45°-60°, which is not really steep by comparison with some other areas. Obviously it is possible to get good results on these slopes, but only by the outlay of very considerable expenditure, which many proprietors and company directors are somewhat reluctant to allow. The proprietor of Kobomella—Mr. Jayasuriya—is apt to suffer from temporary deafness, particularly when asked about the actual costs involved so far on this clearing: however, I understand that this deafness is only very temporary and not likely to recur when it comes to answering questions on the enormous yields (and profits) he rightly expects in a few years.

I will just run quickly through some of the practical points illustrated which you should note particularly; first the very fine stone walls, the stone for which came from the contour trenches which were dug for the lines of tea plants; note that on this slope not more than two lines of tea plants can be accommodated on each terrace, the planting distance being $4' \times 1\frac{1}{2}'$; then note particularly the very neat lines of stylosanthes growing along the edges of the walls and kept well cut back to form hedges; these are supplemented by a further line of bush green manures in between the tea lines to act as low windbreaks and as protection from the sun. Finally note the gently sloping drains, not more than 25 feet apart, with their reverse saw tooth construction and the paved leader drains. I can well believe that with all these measures there is no waste at all on this clearing, even during the heaviest storm. Incidentally, these photos are being forwarded to the officer-in-charge of the T.R.I. small holdings service to make a selection for distribution to the small holdings officers and tea instructors.

A further point is that the plants shown in the photos have just reached pencil thickness and on such steep slopes I would recommend that layering be adopted; this encourages a hedge type of growth which makes a further valuable contribution towards holding up the soil.

Replanting.—So much for new planting and I now come on to the question of replanting (and soil reconditioning) of old uneconomic tea areas. The whole subject of replanting is of course of great topical importance in view of the proposed tea replanting subsidy scheme, which after the recent total eclipse (I refer, of course, to the crisis in the tea trade) is in the limelight once more, and though I naturally cannot enlarge upon this scheme while it is still "sub judice", it is obvious that suitable financial inducements will be necessary to make large scale replanting a practical proposition.

Now on my recent tour I was particularly struck by the enormous variation in yield between the highest and lowest yielding areas; these often varying on different fields of the same estate between 3-400 lbs. per acre and 12-1,300 lbs. per acre Obviously differences in management cannot account for such a wide variation and, although most of the younger higher yielding fields in this district are showing an encouraging tendency to rise, the oldest and lowest yielding fields are barely maintaining their already low levels. This latter tendency is fairly universal and is not

at all surprising when one recalls that many of the oldest and lowest yielding fields are at least 60 years old. Now it may well be feasible to improve the yields of middle aged tea by intensive re-supplying and intensive cultivation combined with resting and soil improvement measures; high potash manuring, designed to assist in the promotion of new wood growth, is also worth consideration. But in the case of old tea nearing the end of its natural life span the expenditure involved in such measures is wholly unwarranted and here the problem of increasing yields can only be solved adequately by replanting; please note particularly that I do not mean merely re-supplying, but complete re-planting, which is the only logical way firstly of ensuring that the tea is re-aligned on the contour and secondly of allowing soil improvement measures.

Uprooting of old Tea.—Before going on to the question of soil rejuvenation, it would be as well to refer briefly to uprooting of old tea. Various techniques have been evolved for this work and the costs vary widely according to the equipment used; on St. Coombs this variation was between Rs. 475/- and Rs. 1,350/- per acre. Naturally the type of terrain and the number of bushes per acre affect the costs very considerably and, lest you should be unduly alarmed by these figures, I would mention that on Balangoda Group 23,000 bushes were uprooted at a cost per acre of only Rs. 215/-, or Rs. 300/- if depreciation of equipment is included; this was achieved by a Hesford Hercules winch working in conjunction with a Ferguson tractor, and 1 acre per week was uprooted. You may have heard of some estates which claim to be able to do this work at even lower figures than the ones quoted, but in my experience such claims are usually based on a stand of no more than about 1,000 bushes per acre. However, whatever the cost of uprooting may turn out to be in practice it represents only a small fraction of the total cost of replanting, since, including soil reconditioning, this is likely to add up to a figure of around Rs. 5,000/- per acre by the time the new tea comes into bearing.

Such high expenditure can only be fully justified if there is every assurance that the best possible returns will be obtained from the replanted areas. These optimistic results can only be achieved, firstly by soil reconditioning of worn out areas, and secondly by the use of high yielding V.P. material.

Soil Reconditioning.—Here I must emphasize that soil reconditioning is no mere scientist's dream, designed to harass planters, but an essential preliminary to any long term replanting programme. This is especially so where the soil has been exposed for a considerable length of time, for there is nothing so damaging to the crumb structure of the soil, or more lowering of its content of humus, than prolonged exposure to the elements.

Unfortunately I cannot give actual comparative figures at this stage to show the value of soil reconditioning, but an experiment has been laid down at St. Coombs in an area of old tea which is being replanted, part of the field being reconditioned, and part replanted straight away. I have also seen other new clearings (in the low country) where partial soil reconditioning has been carried out by means of trenches filled with whatever loppings and vegetation were available; in some cases ordinary holing has been adopted on an adjacent clearing, and where this has been done a very marked difference in growth has been evident.

The technique of soil reconditioning with Guatemala grass (after the old tea has been uprooted) consists of the following operations:—

First the drains should be dug and the contour marked; the contour lines are then cut to form a series of trenches 18" deep and 12" wide; Guatemala grass is then planted in between these trenches and the loppings used to fill them in. After about 18 months–2 years the Guatemala grass plants are finally cut back at ground level, the accumulated loppings being first treated with sulphate of ammonia at the rate

of 1 cwt. per acre to accelerate decomposition and then covered with soil. The rate of decomposition naturally depends on the weather, but under suitable conditions the trenches should at this elevation be ready for planting within about 3-4 months. Of course, thatching the surface of the ground with Guatemala grass is also effective, but this process is really more applicable to new clearings after planting.

Before going on to the question of V.P. materials I would like to develop a point I mentioned earlier, namely that under tropical conditions at low elevation even the richest soils deteriorate very rapidly when exposed to the elements. The inference from this is that every effort should be made to form and maintain a canopy at all levels; in other words this cover should consist ideally of a high shade canopy of *Albizzia moluccana*, then a cover of medium shade such as gliricidias, then the cover of tea (which I am not forgetting is what you are in fact trying to get) and finally protecting cover crops. I noticed on my recent tour that quite a number of you are still afflicted with large unwanted legacies in the shape of old and derelict albizzias and I was glad to see that these are being rapidly removed. I would, however, urge you to replant with this species and, as I am aware that there is considerable divergence of opinion on this point, I should like to quote the following figures from a low country estate to support my argument. In 1940, the yield on this particular estate was 800 lbs. per acre; in 1941-42 all the albizzias were cut out and an immediate temporary increase in yield resulted, in fact the peak figure of almost 1,200 lbs. per acre was reached in 1942. After that, however, there was an alarming drop to 925 lbs. per acre and this decline continued until in 1950 the yield was 725 lbs. per acre. Now what makes these figures all the more remarkable is the fact that those quoted for 1940 and 1942 (viz. 800 and 1,200 lbs. per acre respectively) were obtained during the fertiliser rationing period when only 45 lbs. of nitrogen per acre were given; in 1948 nitrogen applications almost doubled to 80 lbs. per acre, but in spite of this the yield in 1950 was only 725 lbs. per acre. The only possible deduction from these figures is that the removal of the albizzia shade was primarily responsible for the sensational fall in crop; so please pay particular attention to the immediate replacement of old shade trees (as necessary)—especially in the fields that you have no doubt earmarked for replanting, bearing in mind that the new stand should be well established before removing the old trees.

Regarding cover crops, it is not so easy to obtain reliable figures of their beneficial effects on yields. Several estates are known, however, where substantial yield increases have been obtained since gotukola was established, though there have of course been other contributory factors in these increases. Although this cover is non-leguminous it has the great advantage that no control is needed, except possibly occasional strip forking, and this should make it particularly attractive to small holders. I have already drawn your attention to the value of stylosanthes, which does of course need a certain amount of control, (though not so much as desmodium for instance), and I will conclude this section by pointing out that these covers are also of great practical value in keeping down weeds, which are obviously a major problem here.

Vegetative Propagation.—I come now to the second means I mentioned of ensuring that the best possible results are obtained in new plantings, namely the use of high yielding V.P. material. Now with one or two notable exceptions I was rather disappointed at the lack of progress made with V.P. work in this district and, for the time being at any rate, there does seem to be a strong tendency to "take no thought for the morrow". It may therefore be of interest to note that some of the big (company owned) estates in other districts are holding up their planting programmes until sufficient high yielding clonal material is available. At this stage I must point out that a considerable time lag is inevitable in this type of work and after the high yielding clones have been obtained, 4 years will elapse before sufficient planting material will be available for large scale field planting; it is therefore all the more important that the initial steps should be taken in this regard without further delay.

Now in the time at my disposal I cannot do more than summarise some of the more important aspects of V.P. work. Firstly regarding selection work; while I do not wish to dampen your enthusiasm for making your own selections of V.P. material, it would really be better to make use of those T.R.I. approved clones which are currently available, since these are the product of some 20 years of selection work. Many of the St. Coombs selections are highly successful under a wide range of climatic conditions and elevation, and, although no actual yield figures for this elevation are as yet available, clones Nos. 2024 and 2025 are outstanding both up-country and in the low country, while 2023, 2026 and 25 are outstanding in the low-country. Now in the present context the term "outstanding" is used for clones which are giving yields of the order of 3,000 lbs. per acre and above—in fact No. 2024 has almost touched 4,000 lbs. per acre in the first year of its second cycle at St. Coombs. As the demand for these approved clones is naturally far greater than the supply, it has been decided to limit the number of cuttings that can be made available to any one estate to 100 cuttings of any individual clone, with a limit of 5 clones. In other words a maximum of 500 cuttings can be obtained by any estate from St. Coombs, which supply should produce anything up to 250,000 plants in 4 years time.

Of the few low-country clones, for which yield figures are so far available, only three of our collection, namely S 106, S 123 and S 215 merit consideration at present. Unfortunately the Directors of Sirikandura Estate, where these clones originated, are not willing to fall in with our approved policy of making all our proven clonal material freely available and these clones can at present only be obtained from Sirikandura Estate, at prices ranging between 1 and 2 rupees per cutting; there is also a considerable weight of legal documents attached to these particular clones, prohibiting their re-distribution, but in spite of this they do really grow which is the main thing.

The second point is that—as you will have noted—I have consistently referred to the distribution of cuttings to estates and in fact it is no longer possible to obtain rooted plants through the T.R.I. This policy was adopted, partly owing to the danger of transporting soil borne pests such as eelworm in the soil, and partly owing to the very poor results achieved when rooted plants are moved to a different climate. Keeping cuttings fresh in transit now presents no difficulty at all with the latest technique of using polythene tubing for packing (exhibit), and in fact I have kept some cuttings quite fresh in these bags for over a week at Pembroke.

A third point which concerns the propagation of V.P. cuttings in the nursery, is that an overhead pandal of coir matting is a far more satisfactory method of shading than bracken fern. If, however, you propose to continue using bracken fern then better results will be obtained by using it as an overhead pandal rather than just stuck in the ground.

To summarise this section it has been established that yields of 3,000-4,000 lbs. per acre are a definite possibility with selected clonal material, and I strongly urge, that planters in this district should regard the early establishment of multiplication plots with T.R.I. approved clones as being a matter of the utmost importance and urgency.

Pests.—Coming finally to the pests which are causing a good deal of concern in this district, namely yellow mite and red spider. Taking yellow mite first (exhibit), the symptoms are readily visible—even in the early stages—on the under surfaces of the flush, becoming apparent later on the mature leaves; considerable defoliation may be caused on the young shoots. Affected bushes are normally found in patches, often under heavy shade. The pest is to some extent controlled by weather conditions, and outbreaks usually diminish or disappear entirely after heavy rain; should an attack persist, however, it is advisable to control it artificially, as loss of crop may be very considerable. It is fairly easy to control, by either of the following

methods:—(i) two rounds of hard plucking (to limit the amount of young leaf on which the mites feed), followed by a corresponding period of rest to allow the bushes to recover from the physiological effects. (ii) If this is not entirely effective, then it may be necessary to apply sulphur to the affected bushes—either in the form of dust or a dispersible sulphur spray. Two applications at an interval of one week should be sufficient, the first being given immediately after plucking. Although sulphur is highly effective, it has the disadvantage that it causes serious taint, and accordingly it is essential that the leaf from treated areas be discarded for a period of 3 weeks following the last application; obviously therefore this means of control is only worth carrying out if fairly large patches rather than individual bushes are affected.

Turning to the other type of mite which is now fairly wide-spread in this district, namely red spider mite (exhibit), this mite first attacks the mature foliage, causing a coppery discolouration on the upper surfaces; soon the flush becomes similarly affected, and in fact seriously affected bushes may have no flush at all. In common with yellow mite this pest is also controlled to some extent by weather conditions, but not entirely, and I understand that one estate in this district had a major attack last year which has to some extent persisted. Sulphur is very effective in the control of this pest, but on the various estates where it was seen, my impression was that it was confined to scattered bushes, so again this method of control has its limitations. However experiments carried out with a new non-tainting acaricide, chlorobenzylate, have so far proved highly successful and, although this product is double the cost of sulphur, (Rs. 80/- per gallon) it has the great advantage that there is no taint in leaf plucked one week after application. Two or three applications at intervals of a week should bring any outbreak under complete control and, in view of the possibility that outbreaks may assume epidemic proportions, it would be advisable to carry out this simple but effective control measure. The recommended application rate for chlorobenzylate is $\frac{1}{2}$ pint of the chemical in 50 gallons of water per acre per round. (I should be glad if anyone who does decide to undertake this control measure would please keep me informed regarding the results achieved.)

I hope that this survey has covered your problems adequately. I will conclude by saying that if you require my services at any time in connection with any problem which may arise, all you have to do is to get in touch with me.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, ON FRIDAY, SEPTEMBER 2ND, 1955, AT 10-00 A. M.

Present.—Messrs. H. S. Hurst (Chairman), K. G. Sinclair (Chairman, Planters' Association of Ceylon), C. F. H. Edwards (Chairman, Agency Section, Planters' Association of Ceylon), R. H. Wickramasinghe, M.B.E. (representing the Minister of Finance), D. C. L. Amarasinghe, C.C.S. (Tea Controller), Dr. A. W. R. Joachim, O.B.E. (Director of Agriculture), Senator E. W. Kannangara, C.B.E. (Chairman, Low-Country Products Association), Messrs. G. K. Newton, J. L. D. Pieris, F. Amarasuriya, U. B. Unamboowe, O.B.E., M.P., A. Divitotawela, A. R. Cathcart, H. Stacey Hawkes, G. J. Harris and G. B. Portsmouth (Director and Secretary).

Also.—Messrs. G. A. D. Kehl and J. V. Harbord (T.R.I.).

Letters regretting inability to attend were received from Messrs. A. D. McLeod and V. G. W. Ratnayake M.B.E., M.P.

1. Notice convening the meeting was read. The chairman welcomed Mr. A. Divitotawela and Senator E. W. Kannangara to the Board, and Mr. G. J. Harris, who had agreed to act for Mr. Green.

2. **Minutes of the Board Meeting held on 3rd June, 1955**

The minutes were confirmed.

3. **Matters arising out of the Minutes**

(i) **Appointment of Director.**—The Chairman said that this matter would be taken first and asked Mr. Portsmouth to retire temporarily.

The Chairman reported on steps taken by him since the last meeting. Mr. Newton proposed that Mr. G. B. Portsmouth be appointed Director on the same terms as Mr. Lamb as from the date of Mr. Lamb's departure from Ceylon. Mr. Sinclair seconded the motion which was passed unanimously.

On Mr. Portsmouth's recall to the meeting the Chairman announced that the Board had pleasure in unanimously confirming his appointment as Director on the same terms as enjoyed by Mr. Lamb, except that the "Entertainment allowance" would now become part of the basic salary. The appointment was made retrospective to May 17th, 1955, the date Mr. Lamb left the Institute.

The new Director thanked the Board for the confidence they had placed in him and assured them of his whole-hearted desire to continue to serve them as faithfully in the future as he hoped he had always done in the past.

(ii) **Clonal Proving Stations.**—(*a*) PASSARA.—The survey had been completed, but the plan had not been received. An officer had been appointed to take charge of the station. He had been at St. Coombs to learn the details of the job, and would shortly be moving to Passara.

(*b*) NEUCHATEL.—The Director reported that he was visiting Neuchatel estate the next day, and hoped to finalise all outstanding points with the Acting Manager. The Board agreed that a survey could be made at the Institute's expense, if this proved necessary.

4. Membership of the Board and Committees

(i) It was reported that Mr. A. Divitotawela had been appointed by the Minister of Agriculture and Food to represent Small Holders as from June 9th, 1955, for a period of three years.

(ii) It was reported that Mr. G. J. Harris had been nominated by the Agency Section of the Planters' Association of Ceylon to act for Mr. C. D. Green, who was away on leave.

(iii) The Board formally approved the nomination of Mr. R. H. Wickramasinghe to the Finance Sub-Committee.

5. Minutes of the Small Holdings Sub-Committee Meeting held on June 2nd, 1955

The minutes were approved in toto.

6. Matters arising out of the Small Holdings Sub-Committee Meeting held on September 1st 1955

(i) The immediate appointment of a further Tea Instructor to act as a Photographic Assistant was approved. This appointment had been recommended by Mr. Middleditch.

(ii) Rs. 23,000/- was approved for publication of 10,000 copies of a book by Mr. Illankoon, written in sinhalese, on the subject of tea planting. Members commended the author for this work, and referred the question of a selling price for the book back to the Small Holdings Sub-Committee with the stipulation that the price should be not less than 50 cents per copy.

(iii) Following a suggestion by Mr. Newton there was some discussion on the use of the wireless for propaganda purposes. The suggestion was referred to the Small Holdings Sub-Committee for its views.

7. Minutes of the Standing Committee Meeting held on August 5th, 1955

(i) **Water Supply Scheme.**—The Director reported that he had asked the Paterson Engineering Company for an introduction to a suitable Consulting Engineer, and he expected a reply very shortly.

(ii) **Appointment of Dr. Judenko—Entomologist.**—The Director reported that Dr. Judenko had spent two days at St. Coombs after his arrival, and was now in residence at Millawitiya, making a preliminary survey of the problem to be studied.

(iii) **Draft contracts for Senior Staff.**—These had been circulated to members. They were approved, and the Director was instructed to pass them to the Board's lawyers for putting into legal phraseology.

(iv) **Mattakelle-Langdale Road.**—The Director reported that the Superintendent of Mattakelle Estate had accepted the offer of Rs. 250/- per annum towards the upkeep of this road. No reply had yet been received from Bearwell.

The minutes of the Standing Committee and the appendix thereto were approved.

8. **Minutes of the Experimental and Estate Committee Meeting held on August 6th, 1955**

The minutes were approved.

9. **Any Other Business**

(i) **Audited Accounts and Annual Report of the Board.**—These had been circulated and approved, and were now in the press. Mr. Pieris proposed the adoption of the accounts. Seconded by Mr. Unamboowe. Agreed.

Sgd. G. B. PORTSMOUTH,
Secretary.

Tea Research Institute of Ceylon,
St. Coombs,
Talawakelle.

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